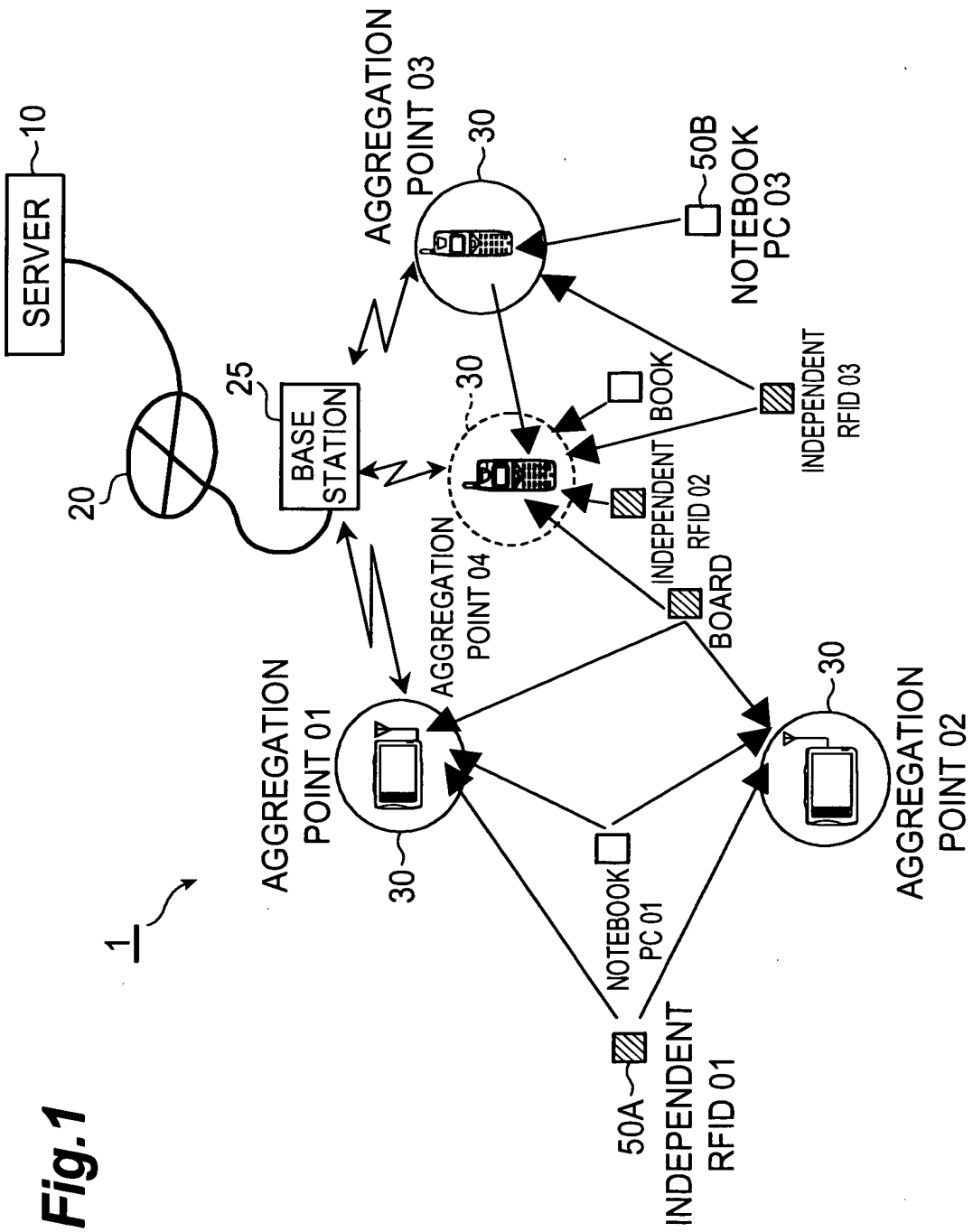

SERVER
10
20
25
BASE STATION
AGGREGATION POINT 03
30
50B
NOTEBOOK PC 03
INDEPENDENT RFID 03
BOOK
INDEPENDENT RFID 02
AGGREGATION POINT 04
BOARD
AGGREGATION POINT 01
AGGREGATION POINT 02
NOTEBOOK PC 01
50A
INDEPENDENT RFID 01
1

Fig.1

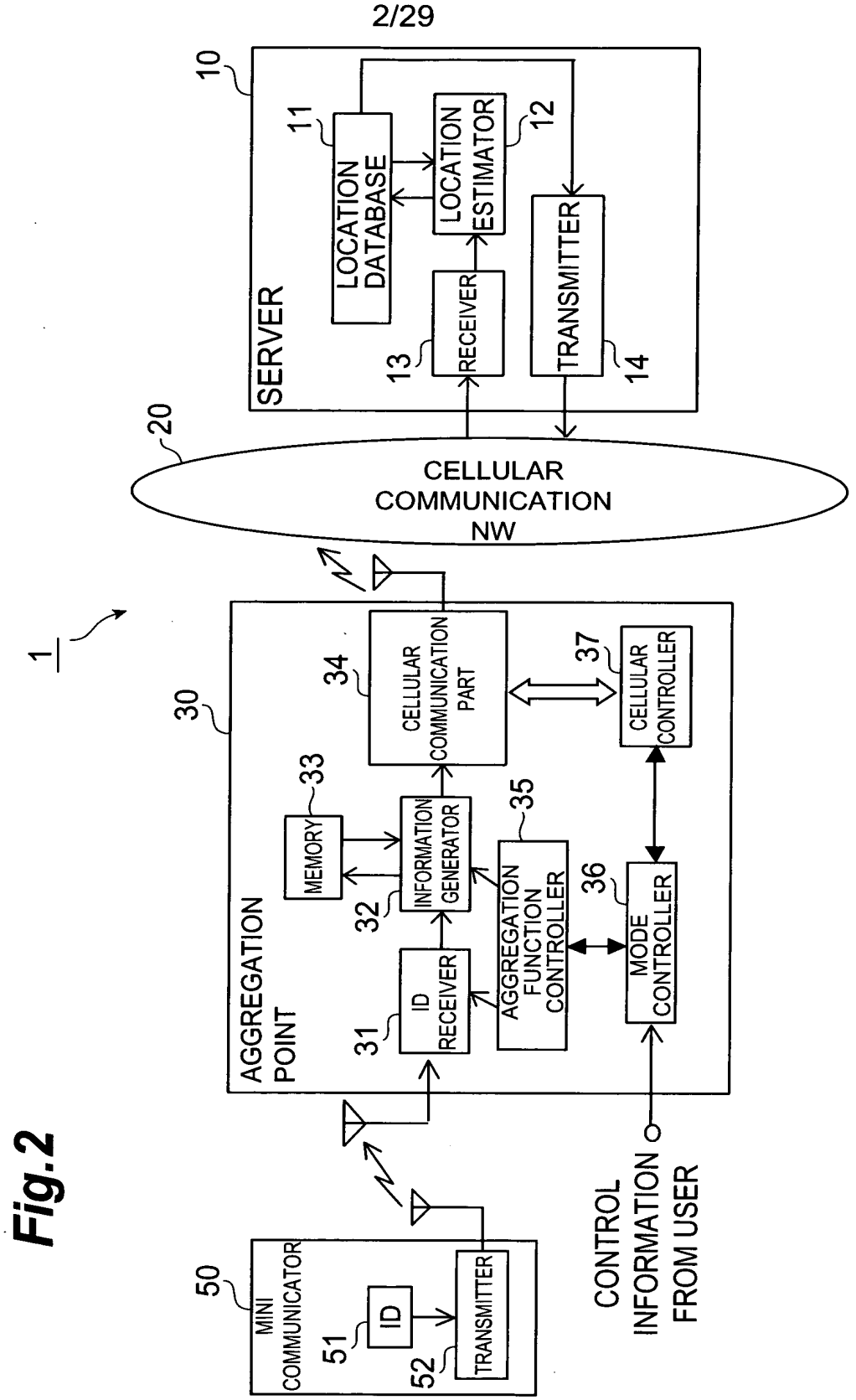

1
10
SERVER
11
LOCATION DATABASE
12
LOCATION ESTIMATOR
13
RECEIVER
14
TRANSMITTER
20
CELLULAR COMMUNICATION NW
30
AGGREGATION POINT
31
ID RECEIVER
32
INFORMATION GENERATOR
33
MEMORY
34
CELLULAR COMMUNICATION PART
35
AGGREGATION FUNCTION CONTROLLER
36
MODE CONTROLLER
37
CELLULAR CONTROLLER
50
MINI COMMUNICATOR
51
ID
52
TRANSMITTER
CONTROL INFORMATION FROM USER

Fig.2

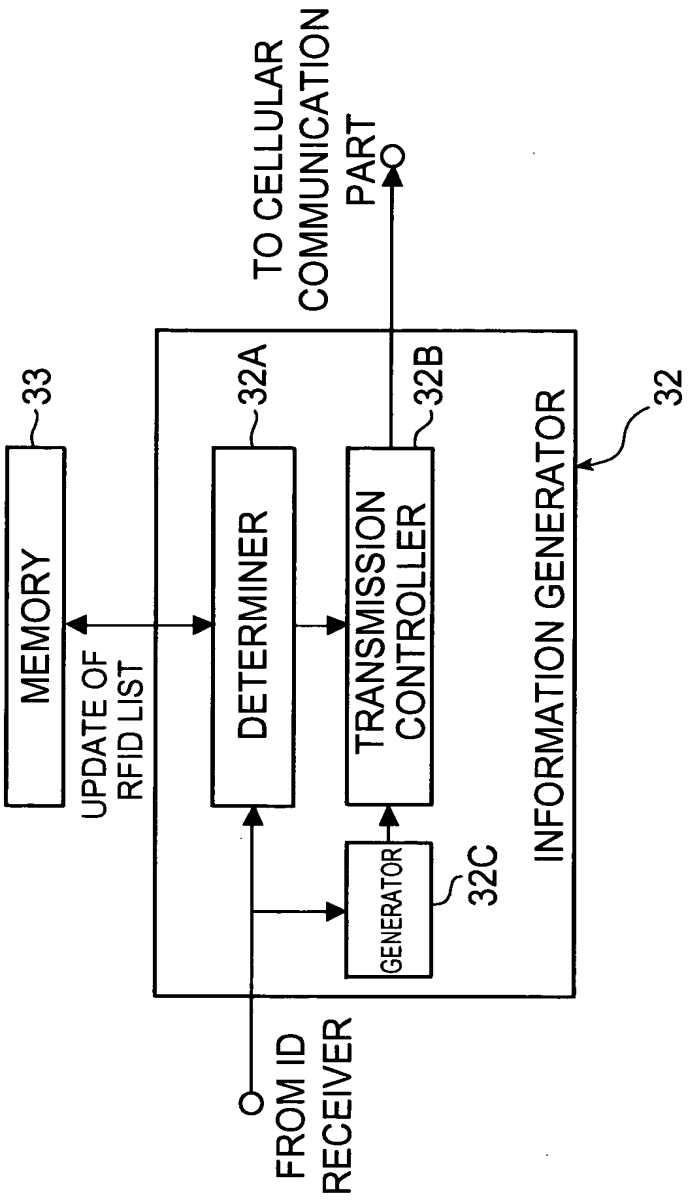

TO CELLULAR COMMUNICATION PART
33
32A
32B
32
MEMORY
UPDATE OF RFID LIST
DETERMINER
TRANSMISSION CONTROLLER
INFORMATION GENERATOR
GENERATOR
32C
FROM ID RECEIVER

Fig.3

Fig.4

41

ID NO.	AGGREGATION POINT NO.	LOCATION CODE	UPDATE TIME	OWNER NO.	RECEPTION INTENSITY (dB)
12345	0002	33331	2002/10/11-23:11	77734	50
12346	0002	00000	2002/10/11-23:11	77734	60
12347	0003	33332	2002/10/11-23:10	77734	20
12347	0004	50001	2002/10/11-23:11	77734	90
12348	0004	50001	2002/10/11-23:20	77735	90
12348	0010	00000	2002/10/11-23:20	77735	10
12349	0012	50010	2002/10/11-23:15	77735	75
12350	0015	55540	2002/10/11-23:16	77735	55
:	:				
:	:				

Fig.5

42

LOCATION CODE	LOCATION INFORMATION
00000	UNDEFINED
33331	FIRST FLOOR AT HOME OF USER A (ENTERED BY USER)
33332	FIRST FLOOR AT HOME OF USER A (ENTERED BY USER)
50001	FIRST FLOOR AT OFFICE OF USER B (ESTIMATED)
50010	SECOND FLOOR AT OFFICE OF USER B (ESTIMATED)
55540	FIRST FLOOR AT FACTORY OF USER B (ESTIMATED)
:	:
:	:

Fig.6

43

AGGREGATION POINT NO.	LOCATION CODE
0001	00000
0002	33331
0003	33332
0004	50001
:	:
:	:

Fig.7

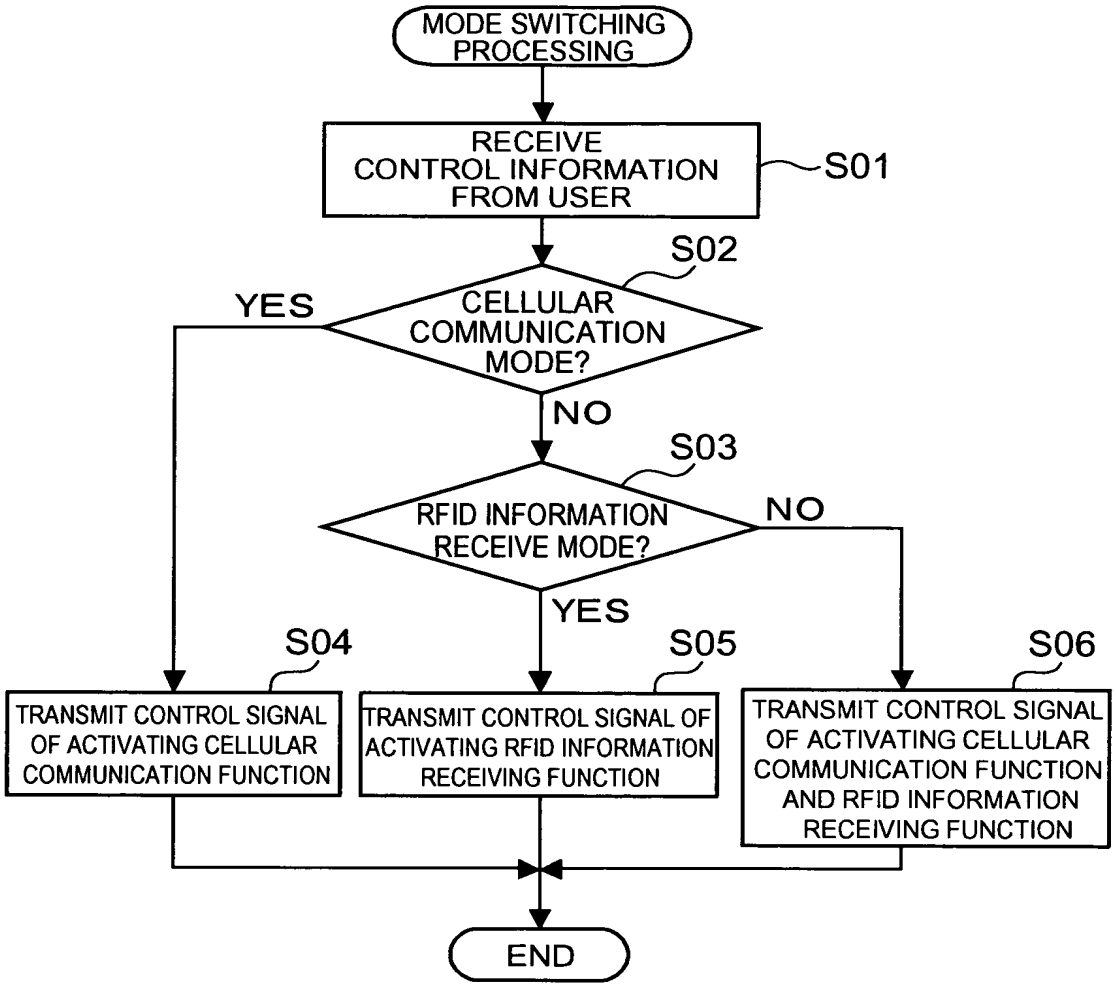
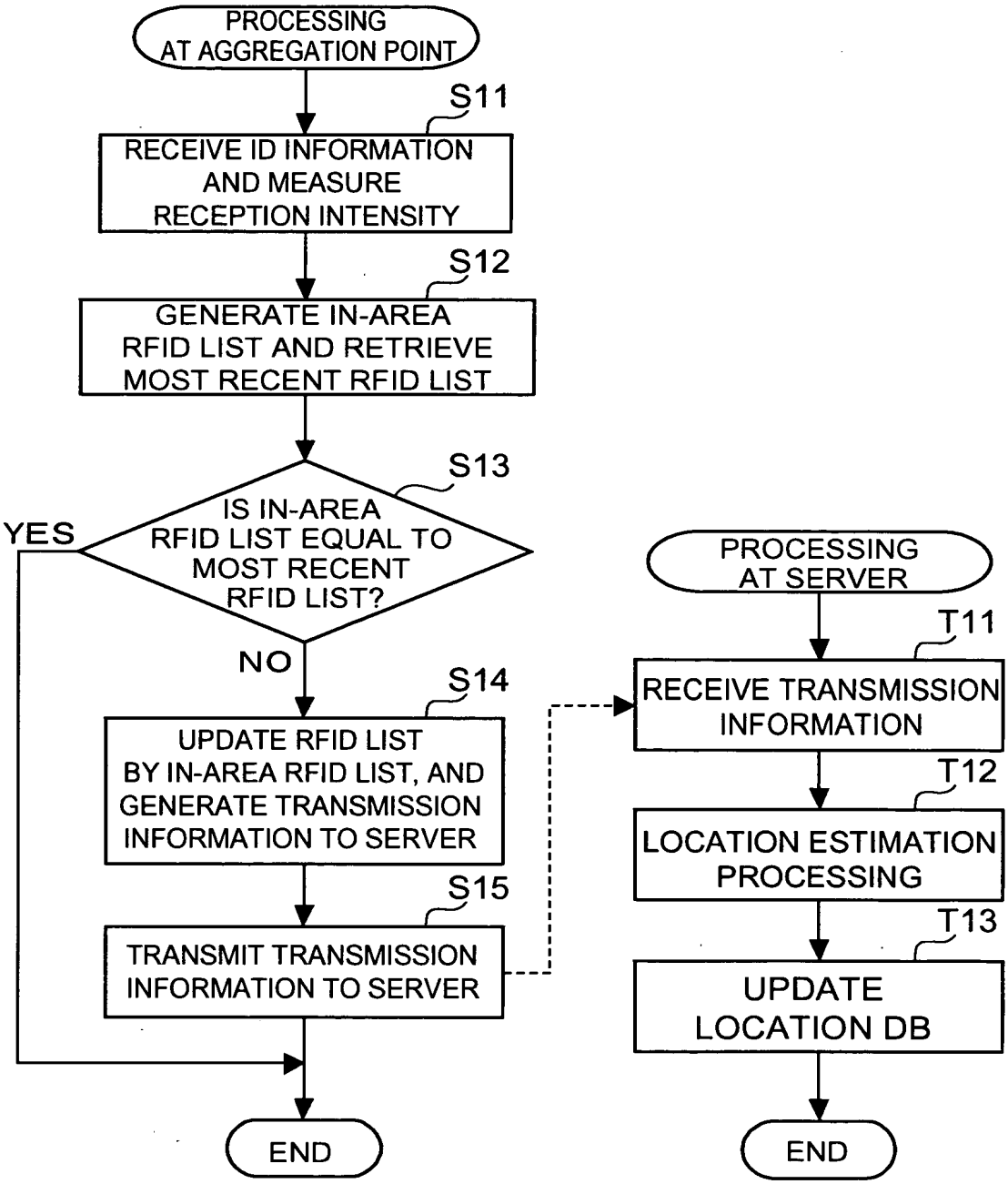

MODE SWITCHING PROCESSING
RECEIVE CONTROL INFORMATION FROM USER
S01
S02
CELLULAR COMMUNICATION MODE?
YES
NO
S03
RFID INFORMATION RECEIVE MODE?
NO
YES
S04
S05
S06
TRANSMIT CONTROL SIGNAL OF ACTIVATING CELLULAR COMMUNICATION FUNCTION
TRANSMIT CONTROL SIGNAL OF ACTIVATING RFID INFORMATION RECEIVING FUNCTION
TRANSMIT CONTROL SIGNAL OF ACTIVATING CELLULAR COMMUNICATION FUNCTION AND RFID INFORMATION RECEIVING FUNCTION
END

Fig.8


PROCESSING AT AGGREGATION POINT
S11
RECEIVE ID INFORMATION AND MEASURE RECEPTION INTENSITY
S12
GENERATE IN-AREA RFID LIST AND RETRIEVE MOST RECENT RFID LIST
S13
IS IN-AREA RFID LIST EQUAL TO MOST RECENT RFID LIST?
YES
NO
S14
UPDATE RFID LIST BY IN-AREA RFID LIST, AND GENERATE TRANSMISSION INFORMATION TO SERVER
S15
TRANSMIT TRANSMISSION INFORMATION TO SERVER
END
PROCESSING AT SERVER
T11
RECEIVE TRANSMISSION INFORMATION
T12
LOCATION ESTIMATION PROCESSING
T13
UPDATE LOCATION DB
END

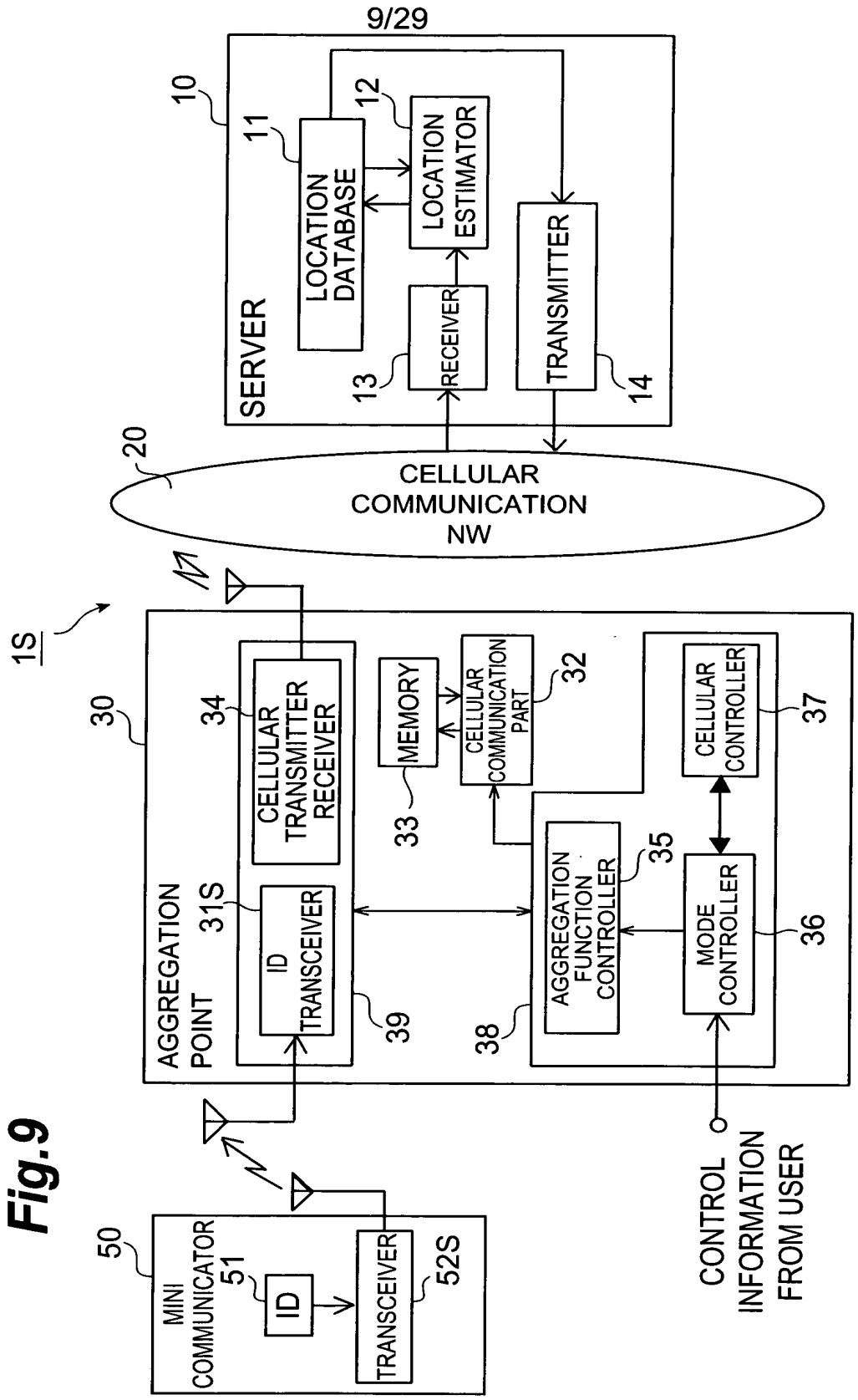

SERVER
10
LOCATION DATABASE
11
LOCATION ESTIMATOR
12
RECEIVER
13
TRANSMITTER
14
CELLULAR COMMUNICATION NW
20
1S
AGGREGATION POINT
30
CELLULAR TRANSMITTER RECEIVER
34
ID TRANSCEIVER
31S
MEMORY
33
CELLULAR COMMUNICATION PART
32
AGGREGATION FUNCTION CONTROLLER
35
MODE CONTROLLER
36
CELLULAR CONTROLLER
37
38
39
MINI COMMUNICATOR
50
ID
51
TRANSCEIVER
52S
CONTROL INFORMATION FROM USER

Fig.9

Fig.10

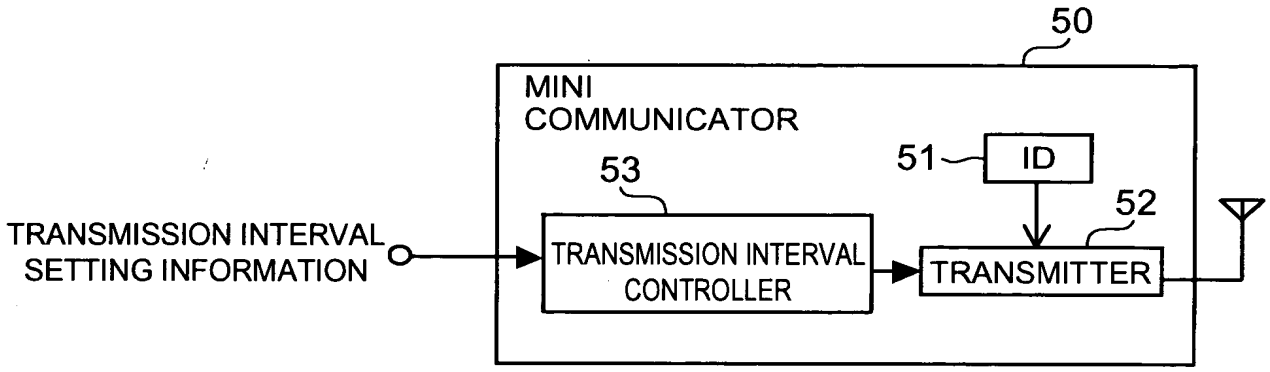
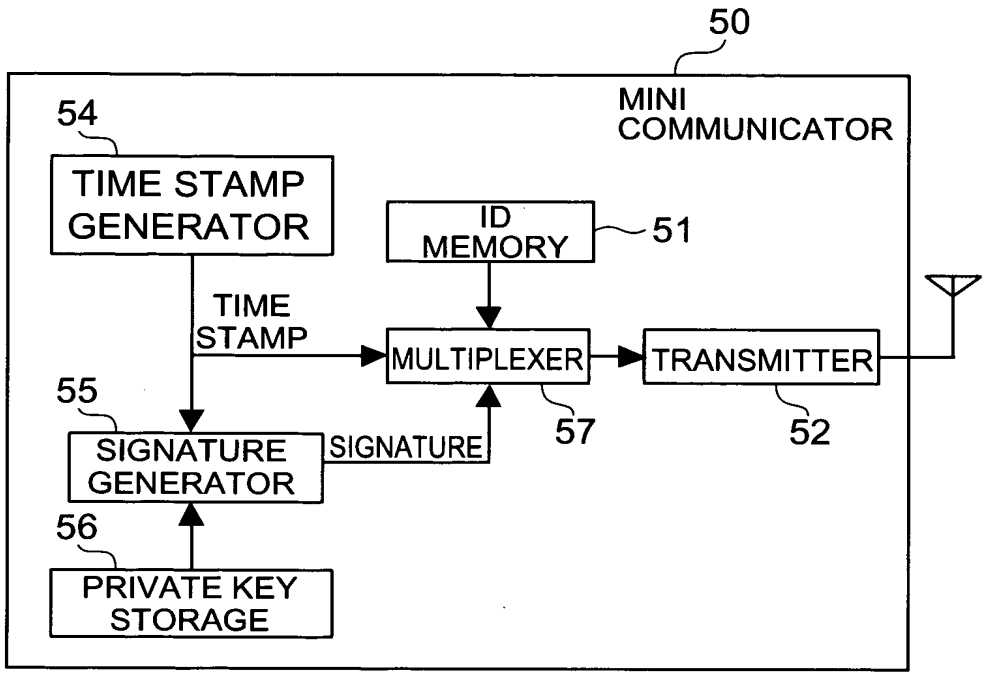

50
MINI
COMMUNICATOR
51
ID
53
52
TRANSMISSION INTERVAL
SETTING INFORMATION
TRANSMISSION INTERVAL
CONTROLLER
TRANSMITTER

Fig.11


50
MINI COMMUNICATOR
54
TIME STAMP GENERATOR
ID MEMORY
51
TIME STAMP
MULTIPLEXER
TRANSMITTER
55
SIGNATURE GENERATOR
SIGNATURE
57
52
56
PRIVATE KEY STORAGE

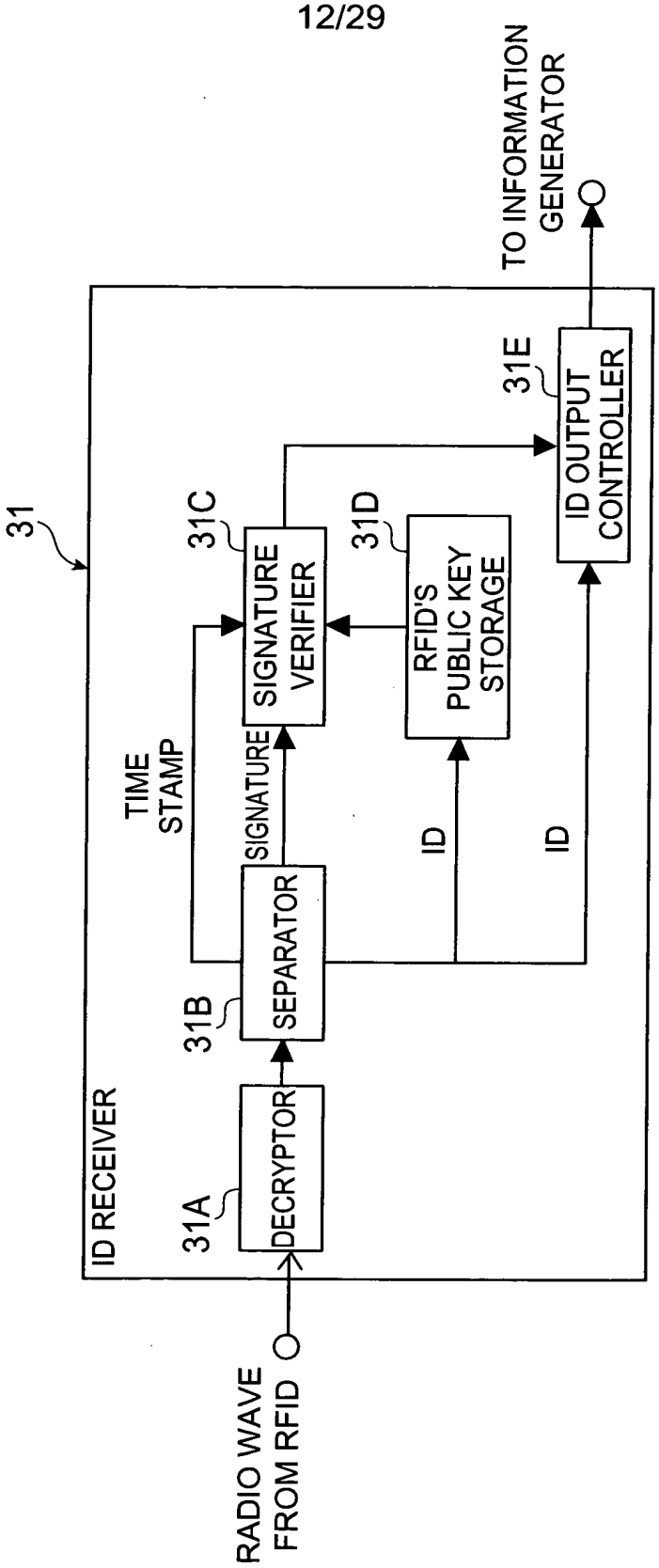

TO INFORMATION GENERATOR
31
31E
ID OUTPUT CONTROLLER
31C
SIGNATURE VERIFIER
31D
RFID'S PUBLIC KEY STORAGE
TIME STAMP
SIGNATURE
ID
ID
31B
SEPARATOR
ID RECEIVER
31A
DECRYPTOR
RADIO WAVE FROM RFID

Fig.12

Fig.13

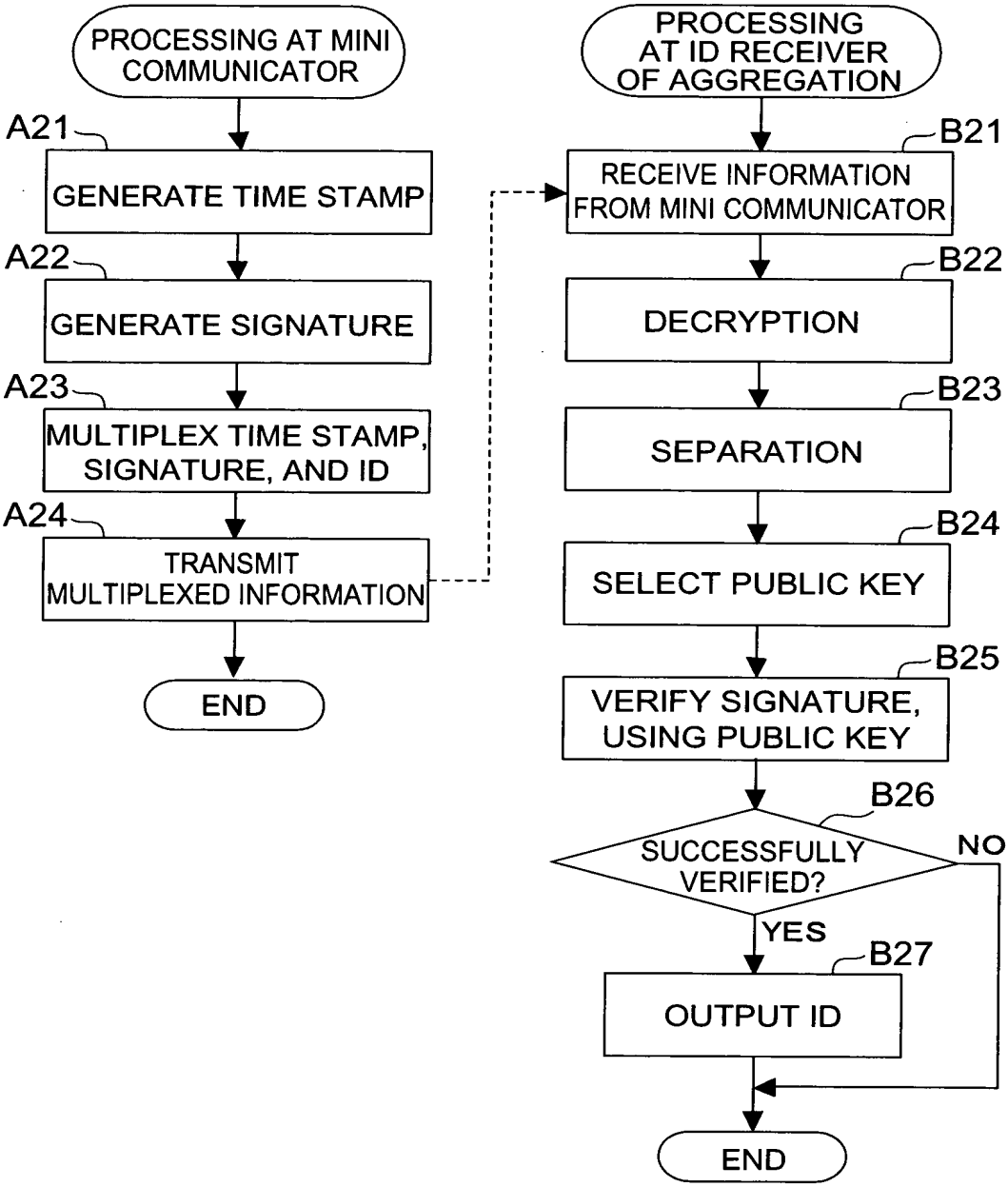
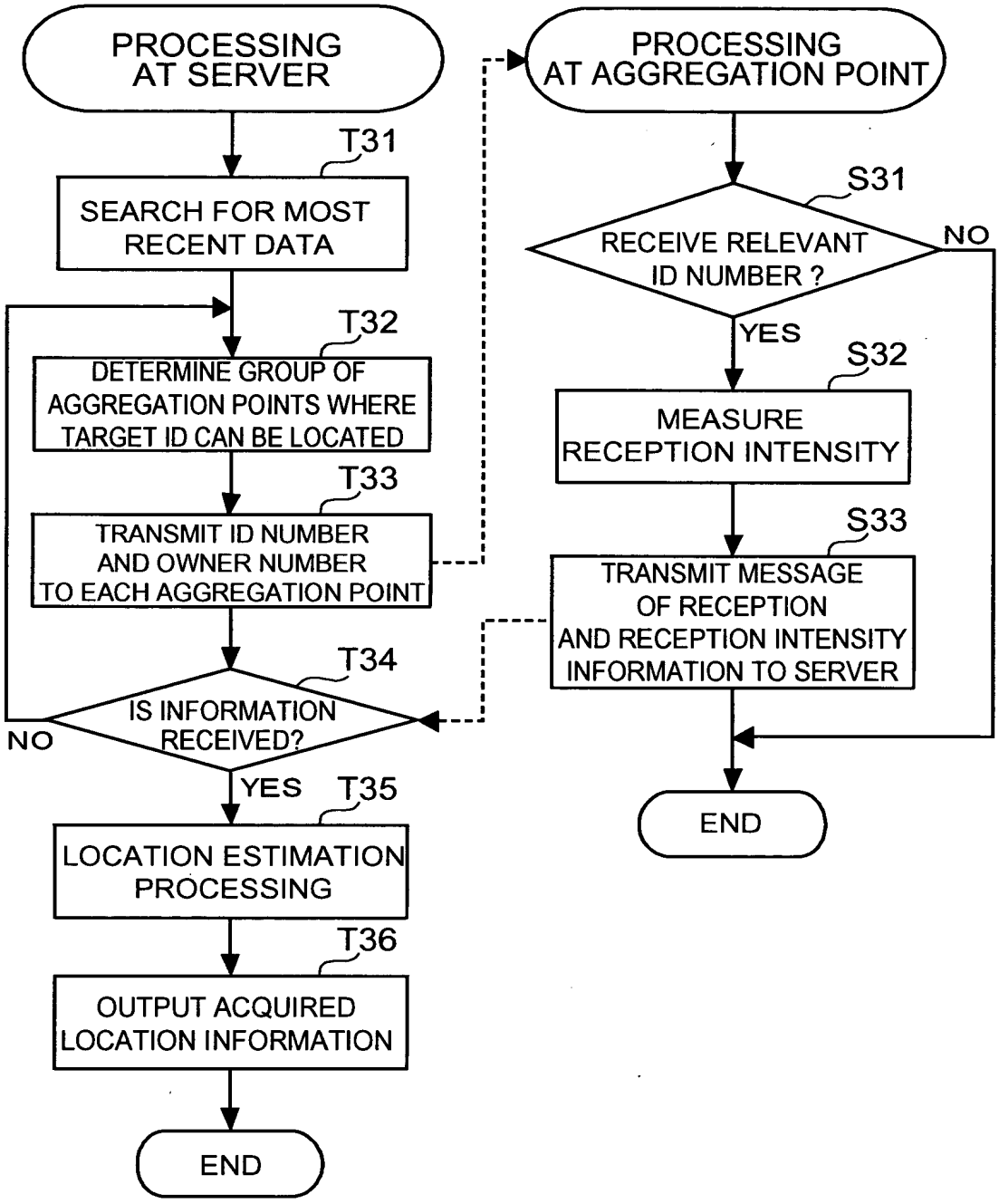

PROCESSING AT MINI COMMUNICATOR
A21
GENERATE TIME STAMP
A22
GENERATE SIGNATURE
A23
MULTIPLEX TIME STAMP, SIGNATURE, AND ID
A24
TRANSMIT MULTIPLEXED INFORMATION
END
PROCESSING AT ID RECEIVER OF AGGREGATION
B21
RECEIVE INFORMATION FROM MINI COMMUNICATOR
B22
DECRYPTION
B23
SEPARATION
B24
SELECT PUBLIC KEY
B25
VERIFY SIGNATURE, USING PUBLIC KEY
B26
SUCCESSFULLY VERIFIED?
NO
YES
B27
OUTPUT ID
END

Fig.14


PROCESSING AT SERVER
T31
SEARCH FOR MOST RECENT DATA
T32
DETERMINE GROUP OF AGGREGATION POINTS WHERE TARGET ID CAN BE LOCATED
T33
TRANSMIT ID NUMBER AND OWNER NUMBER TO EACH AGGREGATION POINT
T34
IS INFORMATION RECEIVED?
NO
YES
T35
LOCATION ESTIMATION PROCESSING
T36
OUTPUT ACQUIRED LOCATION INFORMATION
END
PROCESSING AT AGGREGATION POINT
S31
RECEIVE RELEVANT ID NUMBER ?
NO
YES
S32
MEASURE RECEPTION INTENSITY
S33
TRANSMIT MESSAGE OF RECEPTION AND RECEPTION INTENSITY INFORMATION TO SERVER
END

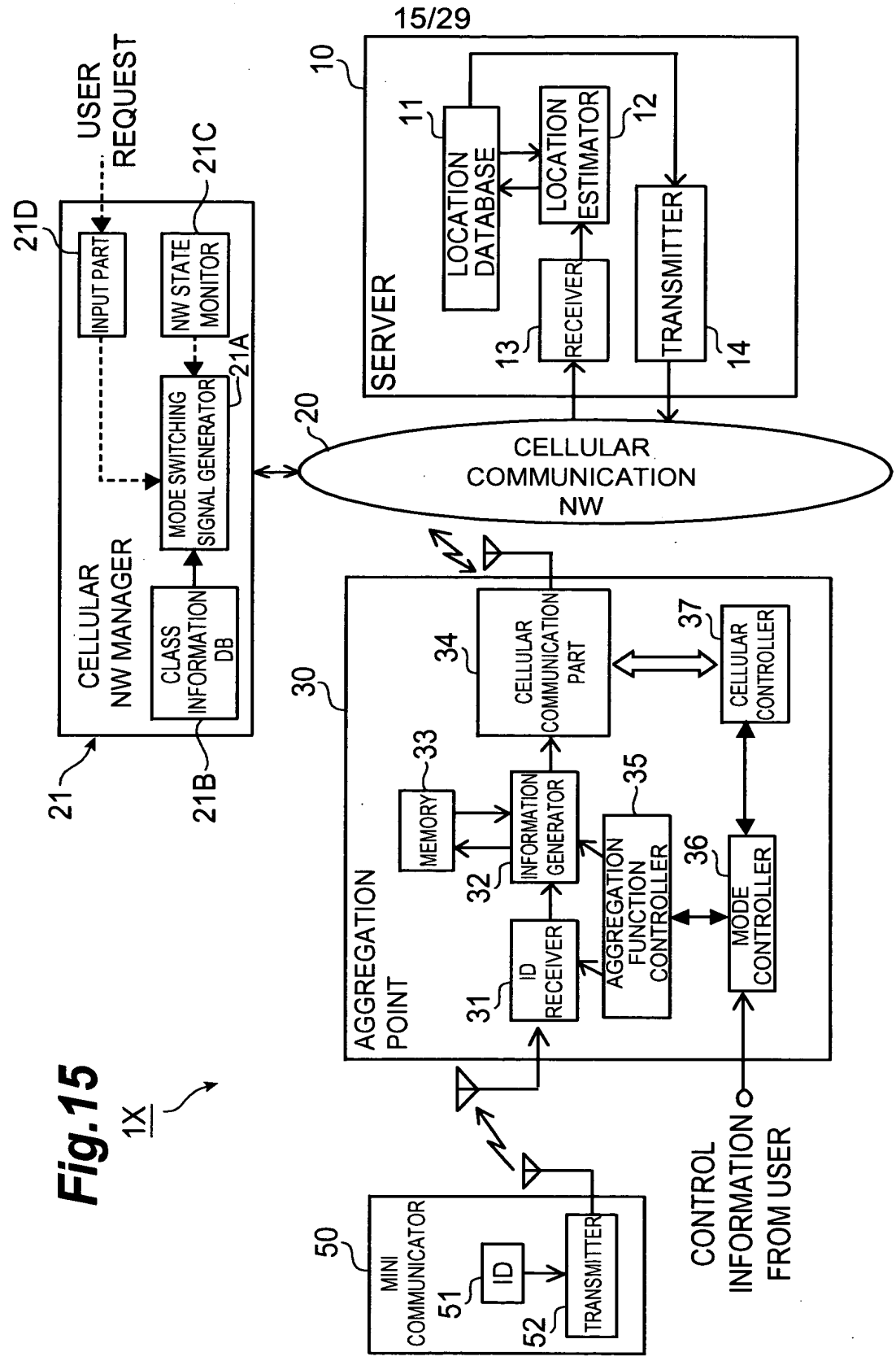
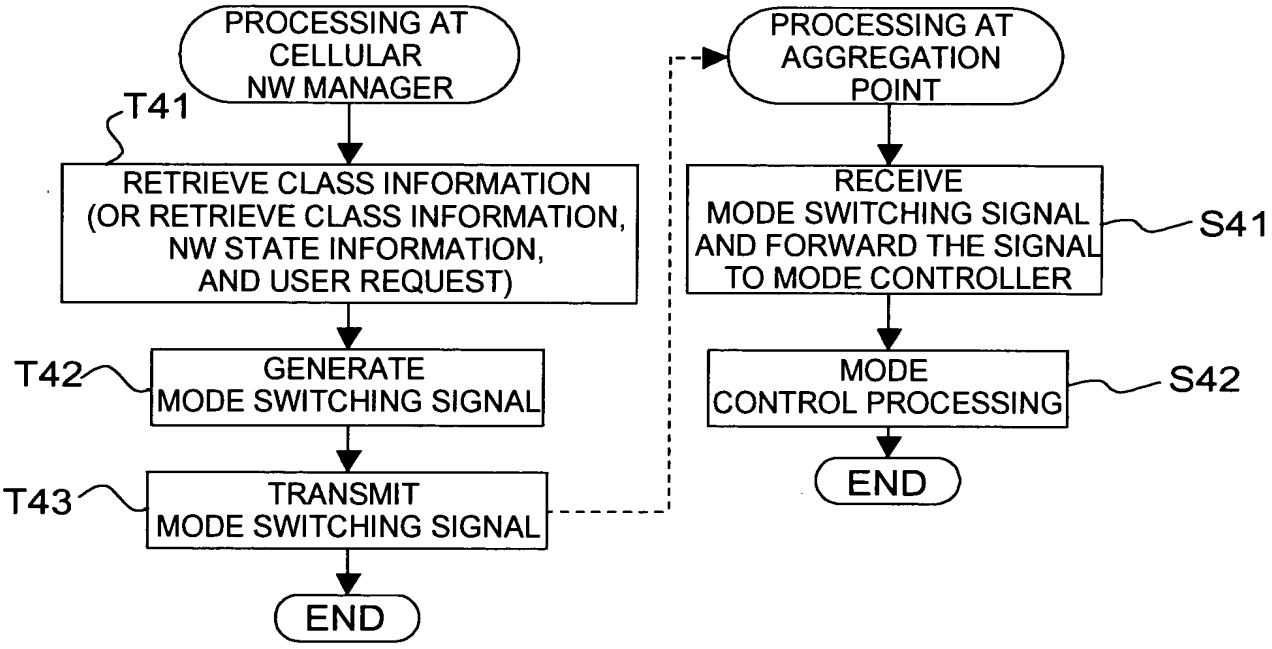

1X
21
CELLULAR NW MANAGER
CLASS INFORMATION DB
21B
MODE SWITCHING SIGNAL GENERATOR
21A
NW STATE MONITOR
21C
INPUT PART
21D
USER REQUEST
20
CELLULAR COMMUNICATION NW
10
SERVER
LOCATION DATABASE
11
LOCATION ESTIMATOR
12
RECEIVER
13
TRANSMITTER
14
30
AGGREGATION POINT
CELLULAR COMMUNICATION PART
34
CELLULAR CONTROLLER
37
MEMORY
33
INFORMATION GENERATOR
32
AGGREGATION FUNCTION CONTROLLER
35
MODE CONTROLLER
36
ID RECEIVER
31
50
MINI COMMUNICATOR
ID
51
TRANSMITTER
52
CONTROL INFORMATION FROM USER

Fig.15

Fig.16


PROCESSING AT CELLULAR NW MANAGER
T41
RETRIEVE CLASS INFORMATION (OR RETRIEVE CLASS INFORMATION, NW STATE INFORMATION, AND USER REQUEST)
T42
GENERATE MODE SWITCHING SIGNAL
T43
TRANSMIT MODE SWITCHING SIGNAL
END
PROCESSING AT AGGREGATION POINT
RECEIVE MODE SWITCHING SIGNAL AND FORWARD THE SIGNAL TO MODE CONTROLLER
S41
MODE CONTROL PROCESSING
S42
END

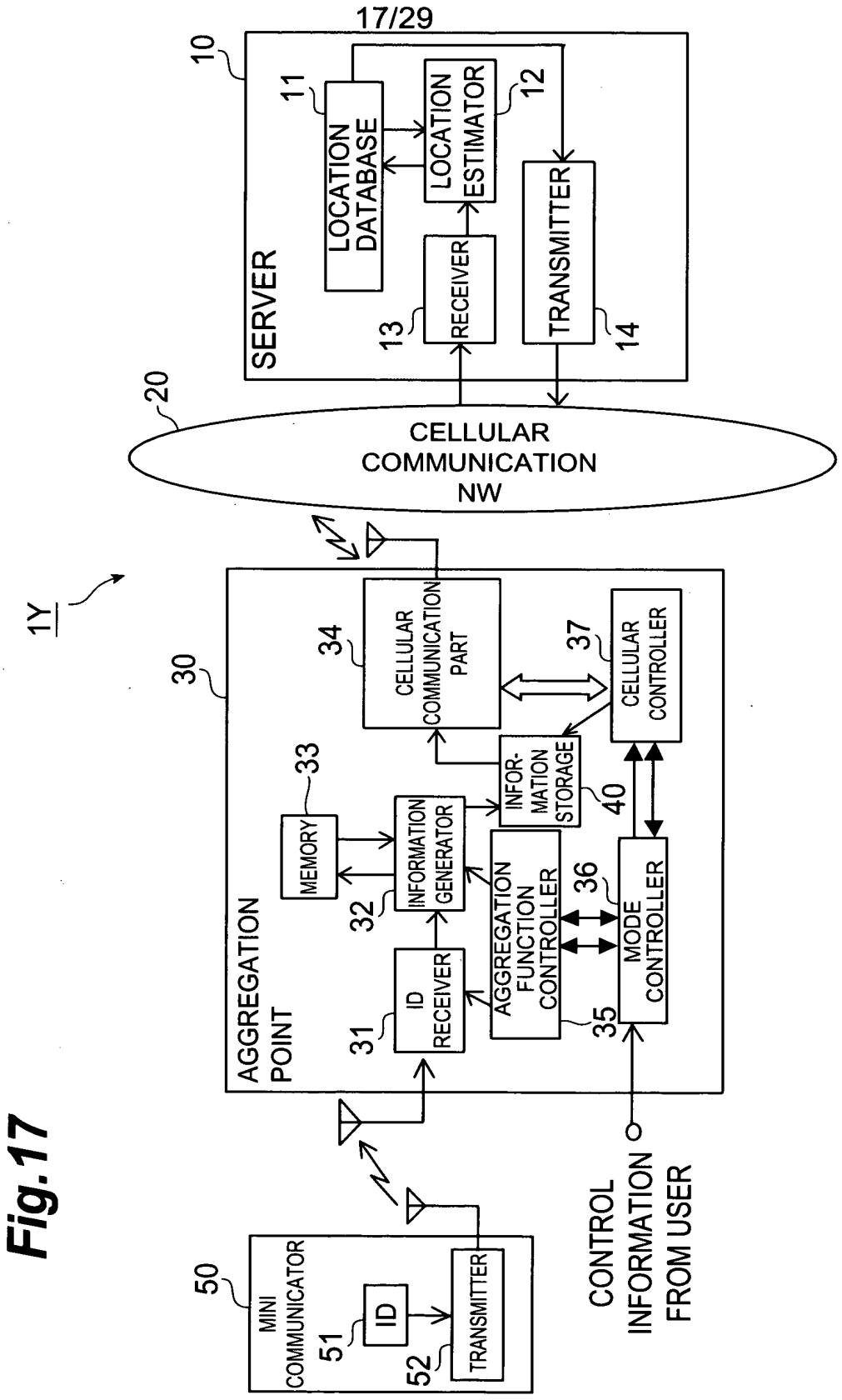

1Y
10
SERVER
11
LOCATION DATABASE
12
LOCATION ESTIMATOR
13
RECEIVER
14
TRANSMITTER
20
CELLULAR COMMUNICATION NW
30
AGGREGATION POINT
31
ID RECEIVER
32
INFORMATION GENERATOR
33
MEMORY
34
CELLULAR COMMUNICATION PART
35
AGGREGATION FUNCTION CONTROLLER
36
MODE CONTROLLER
37
CELLULAR CONTROLLER
40
INFOR-MATION STORAGE
50
MINI COMMUNICATOR
51
ID
52
TRANSMITTER
CONTROL INFORMATION FROM USER

Fig.17

Fig.18

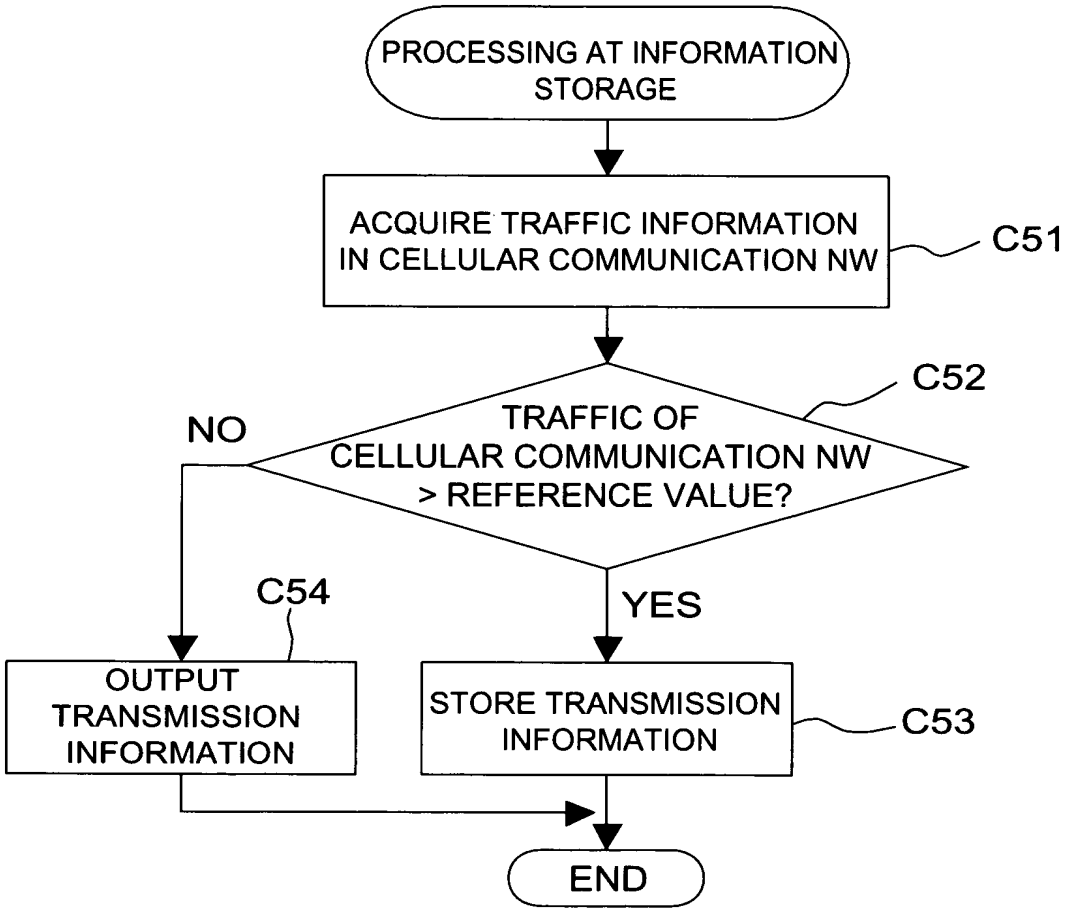

PROCESSING AT INFORMATION STORAGE
ACQUIRE TRAFFIC INFORMATION IN CELLULAR COMMUNICATION NW
C51
TRAFFIC OF CELLULAR COMMUNICATION NW > REFERENCE VALUE?
C52
NO
YES
C54
OUTPUT TRANSMISSION INFORMATION
STORE TRANSMISSION INFORMATION
C53
END

Fig.19A

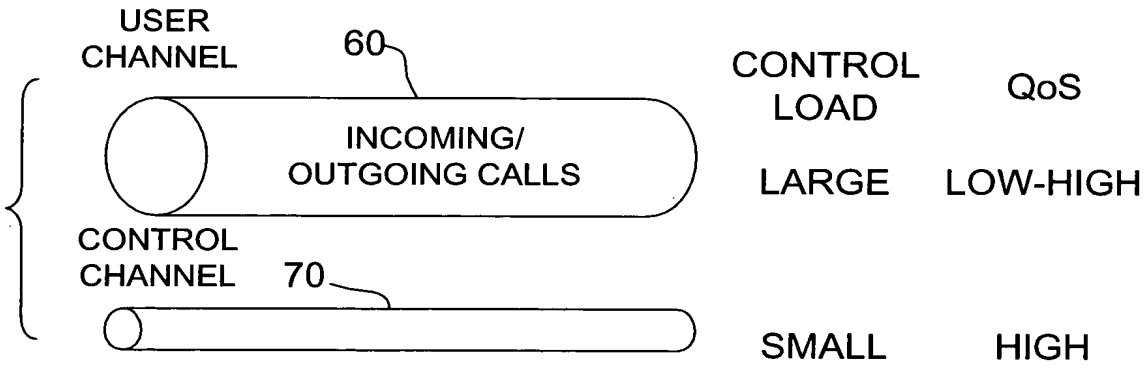


Fig.19B

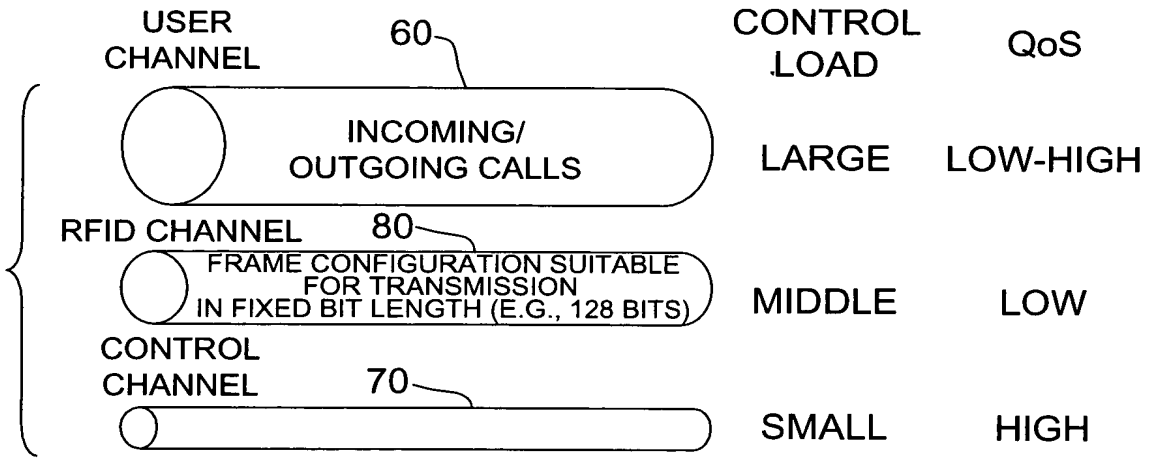
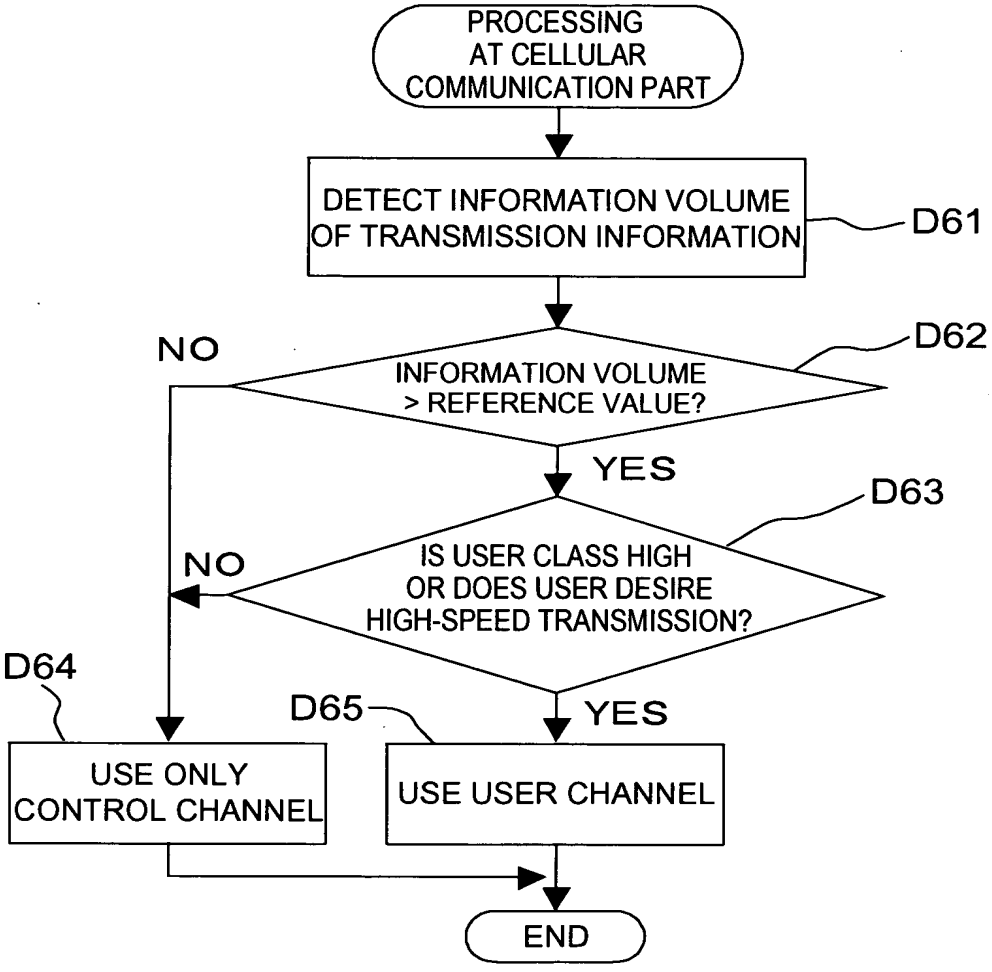


Fig.20


PROCESSING AT CELLULAR COMMUNICATION PART
DETECT INFORMATION VOLUME OF TRANSMISSION INFORMATION
D61
INFORMATION VOLUME > REFERENCE VALUE?
D62
NO
YES
IS USER CLASS HIGH OR DOES USER DESIRE HIGH-SPEED TRANSMISSION?
D63
NO
YES
D64
D65
USE ONLY CONTROL CHANNEL
USE USER CHANNEL
END

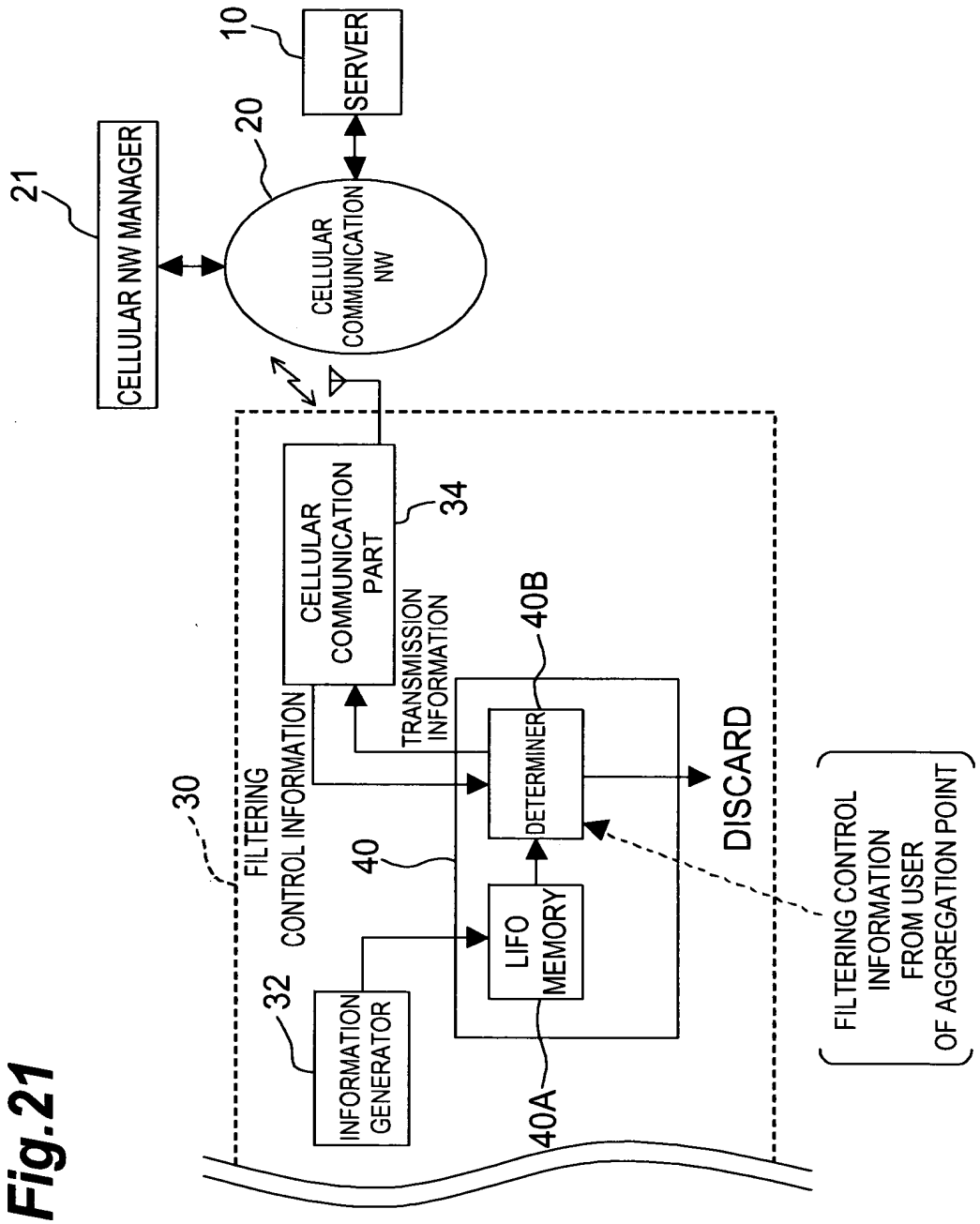
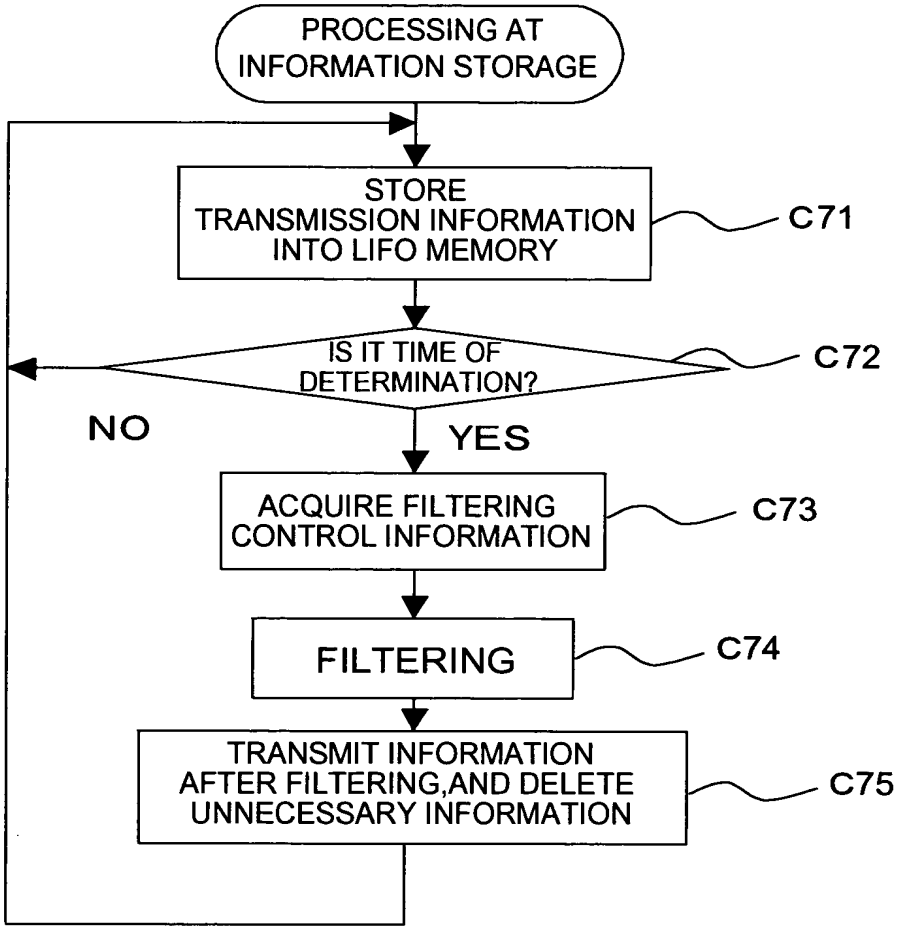

10
SERVER
20
CELLULAR COMMUNICATION NW
21
CELLULAR NW MANAGER
30
FILTERING CONTROL INFORMATION
CELLULAR COMMUNICATION PART
34
TRANSMISSION INFORMATION
40B
DETERMINER
DISCARD
40
LIFO MEMORY
32
INFORMATION GENERATOR
40A
FILTERING CONTROL INFORMATION FROM USER OF AGGREGATION POINT

Fig.21

Fig.22


PROCESSING AT INFORMATION STORAGE
STORE TRANSMISSION INFORMATION INTO LIFO MEMORY
C71
IS IT TIME OF DETERMINATION?
C72
NO
YES
ACQUIRE FILTERING CONTROL INFORMATION
C73
FILTERING
C74
TRANSMIT INFORMATION AFTER FILTERING,AND DELETE UNNECESSARY INFORMATION
C75

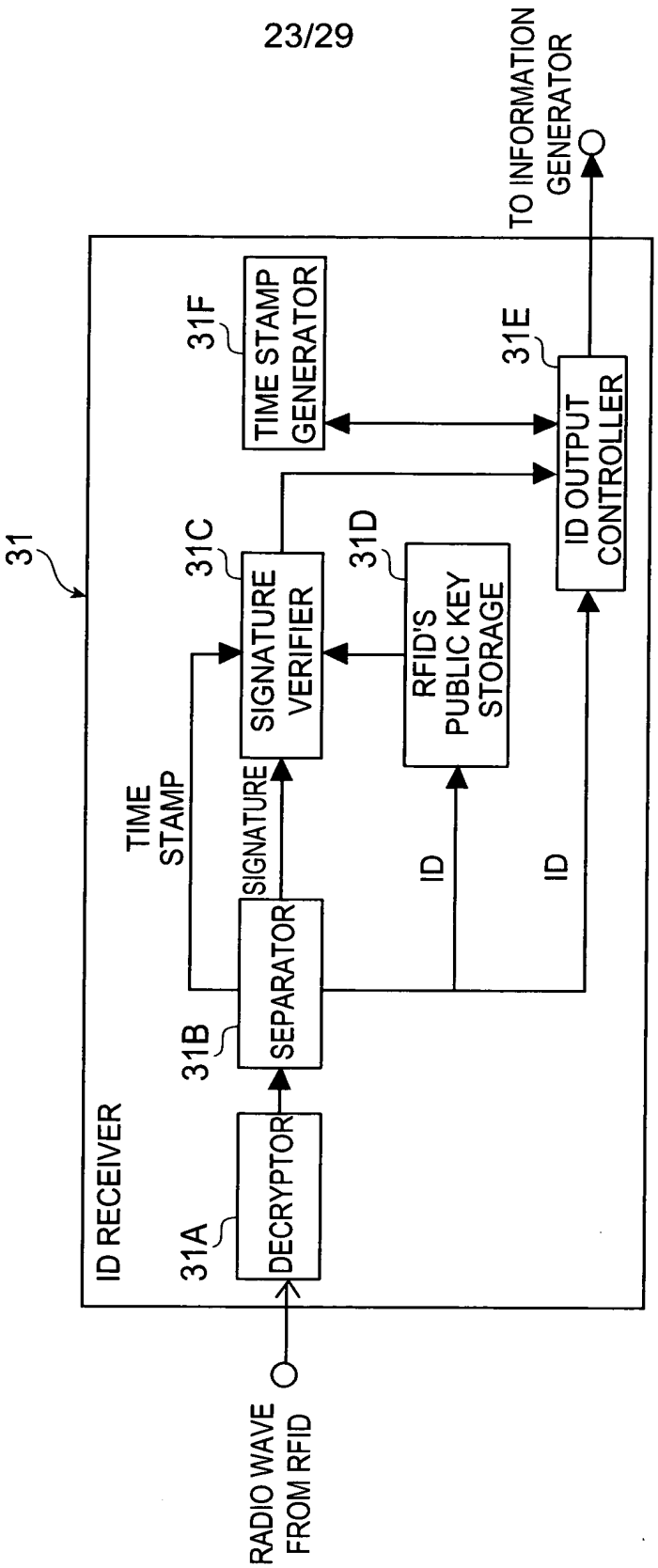

TO INFORMATION GENERATOR
31
ID RECEIVER
31A
DECRYPTOR
31B
SEPARATOR
31C
SIGNATURE VERIFIER
31D
RFID'S PUBLIC KEY STORAGE
31E
ID OUTPUT CONTROLLER
31F
TIME STAMP GENERATOR
TIME STAMP
SIGNATURE
ID
ID
RADIO WAVE FROM RFID

Fig.23

Fig.24

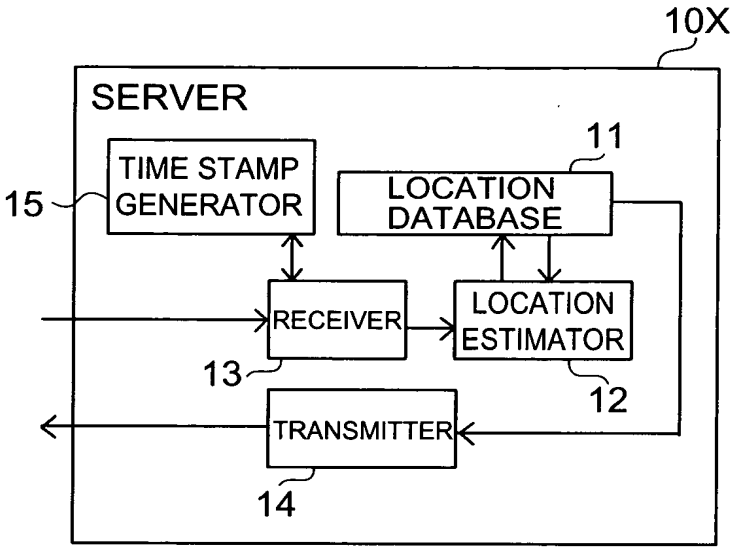

10X
SERVER
TIME STAMP GENERATOR
15
11
LOCATION DATABASE
RECEIVER
LOCATION ESTIMATOR
13
12
TRANSMITTER
14

Fig.25A

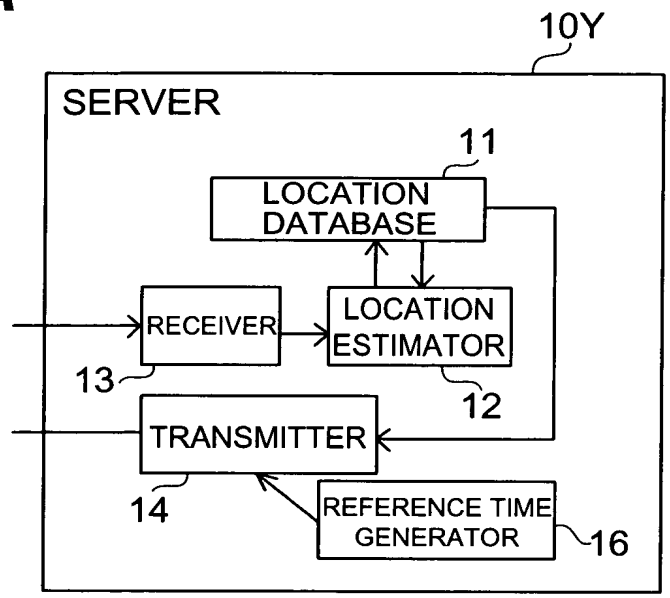


Fig.25B

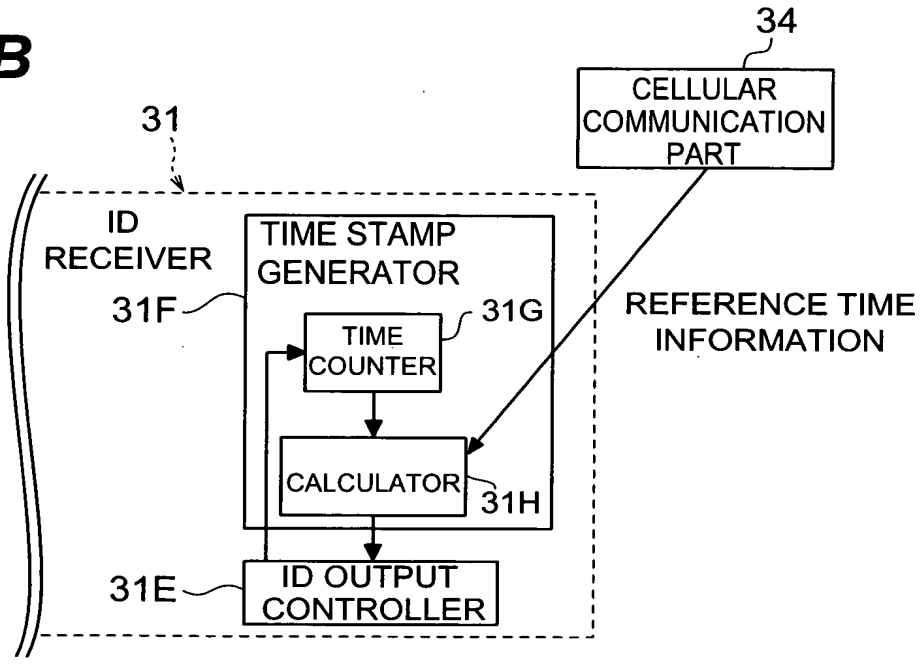


Fig.26

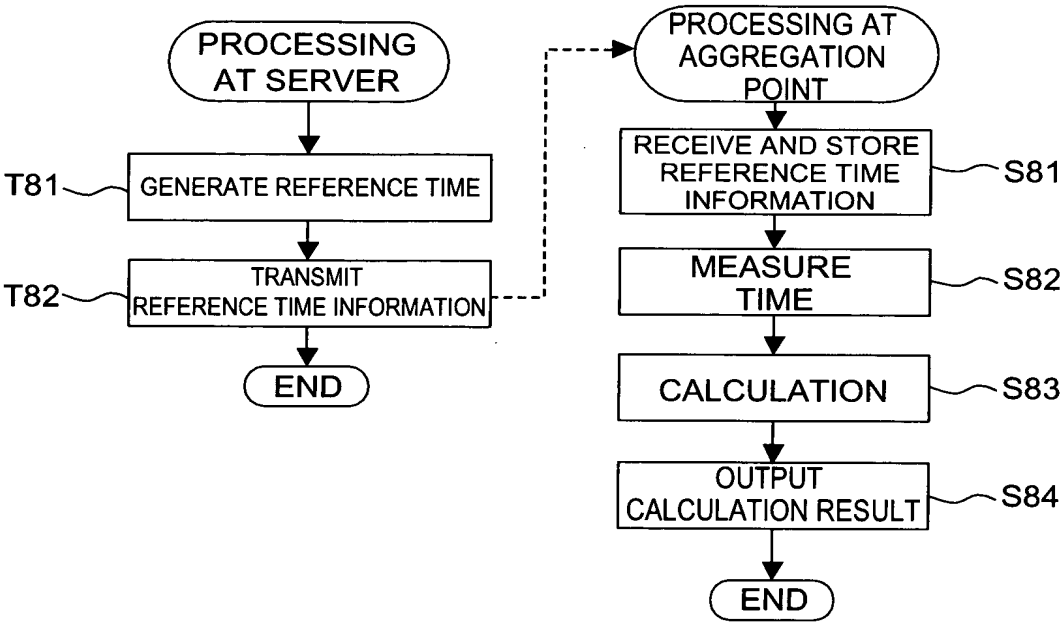

PROCESSING AT SERVER
T81
GENERATE REFERENCE TIME
T82
TRANSMIT REFERENCE TIME INFORMATION
END
PROCESSING AT AGGREGATION POINT
RECEIVE AND STORE REFERENCE TIME INFORMATION
S81
MEASURE TIME
S82
CALCULATION
S83
OUTPUT CALCULATION RESULT
S84
END

Fig.27

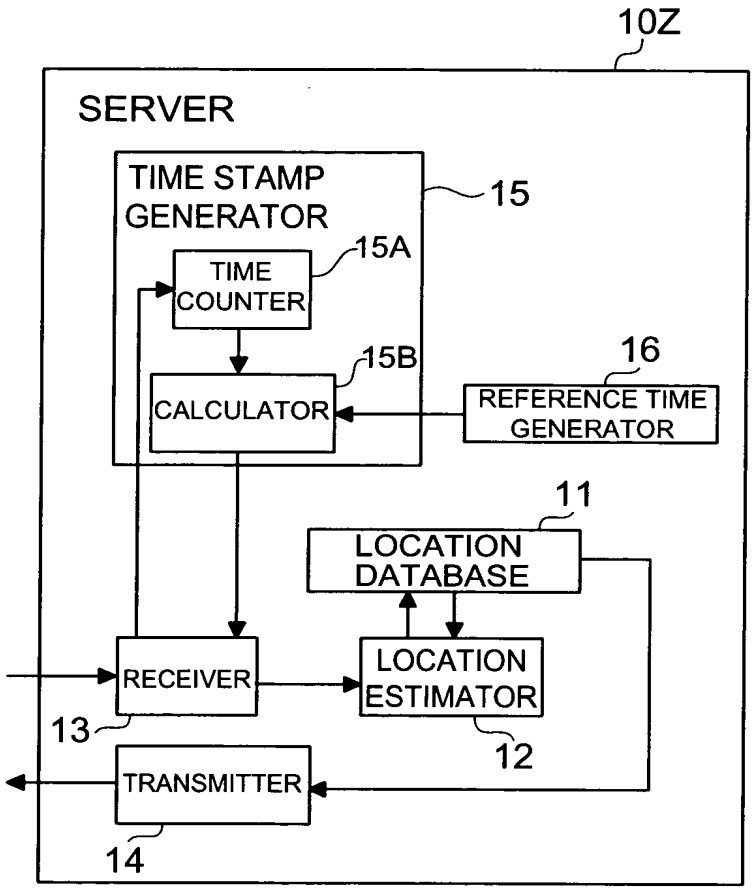

10Z
SERVER
TIME STAMP GENERATOR
15
TIME COUNTER
15A
CALCULATOR
15B
16
REFERENCE TIME GENERATOR
11
LOCATION DATABASE
RECEIVER
LOCATION ESTIMATOR
13
12
TRANSMITTER
14

Fig.28

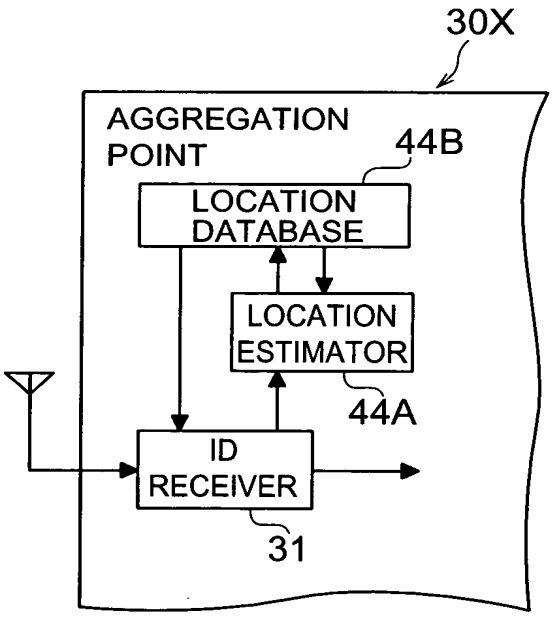

30X
AGGREGATION POINT
44B
LOCATION DATABASE
LOCATION ESTIMATOR
44A
ID RECEIVER
31

Fig.29A

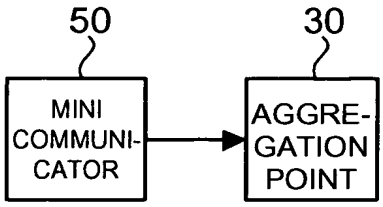


Fig.29B

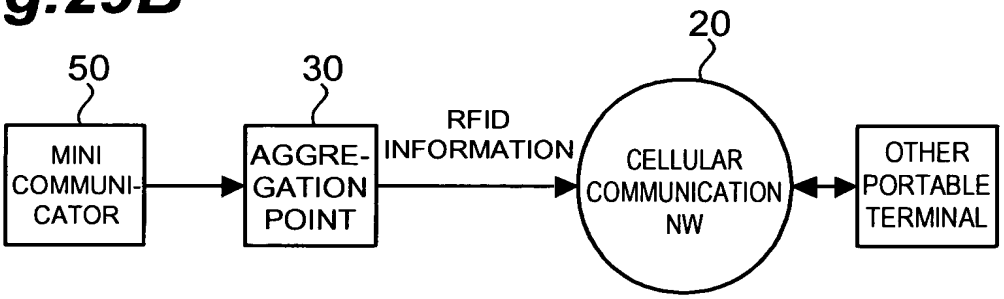


Fig.29C

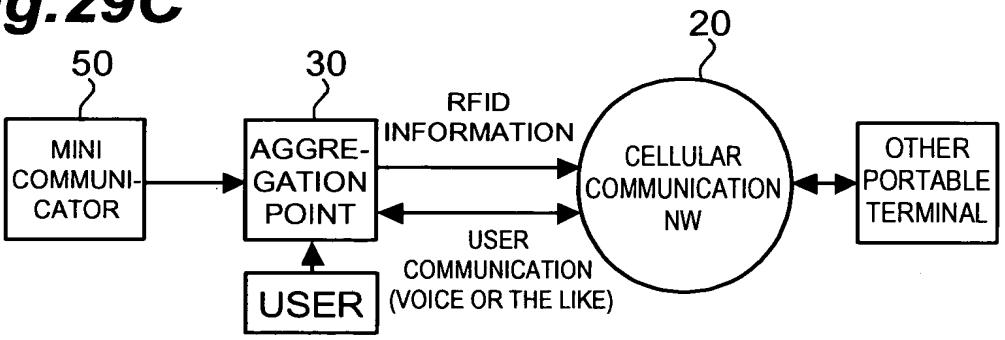
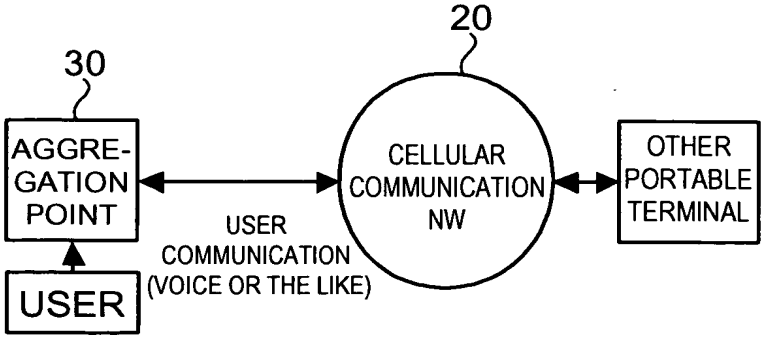



Fig.29D